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09/941,537	08/29/2001	Jong Chen	67,200-477	4317

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EXAMINER
RUGGLES, JOHN S

ART UNIT	PAPER NUMBER
1756	2

DATE MAILED: 04/30/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/941,537	Applicant(s) CHEN ET AL.	
	Examiner John Ruggles	Art Unit 1756	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 August 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☒ Claim(s) *20* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *29 August 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Drawings

Figure 1 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated as admitted in the brief description of this drawing found in paragraph (¶) 0026 on page 13. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "10" in Figure 1 has been used to designate both an inter-metal dielectric (IMD) layer 10 and a photoresist layer 16 as described in ¶ 009 on page 5; this same objection also applies to reference character "38" in Figure 3 which has been used to designate both (1) another (second) dielectric layer 38 formed over a first dielectric layer 30 (found in ¶ 0040 on page 17) and (2) a trench opening pattern 38 defined by photoresist layer 36 (found in ¶ 0042 on page 18). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: Figure 1 does not show photoresist 16 as described in ¶ 009 on page 5 (additional references to photoresist 16 are also found in at least ¶ 0012 and ¶ 0013 on page 7); Figure 2 does not show ARC 22 as described in ¶ 0038 on page 17; and Figure 3 does not show an "at least one ARC layer 36" (note that "36"

is also used to describe photoresist layer 36 (shown in this drawing) over the "at least one additional ARC layer 35") underneath the "at least one additional ARC layer 35" as described in ¶ 0040 on page 18. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Specification

Applicant is reminded of the proper language and format for an abstract of the disclosure.

The abstract should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. It is important that the abstract not exceed 150 words in length since the space provided for the abstract on the computer tape used by the printer is limited. The form and legal phraseology often used in patent claims, such as "means" and "said," should be avoided. The abstract should describe the disclosure sufficiently to assist readers in deciding whether there is a need for consulting the full patent text for details.

The language should be clear and concise and should not repeat information given in the title. It should avoid using phrases which can be implied, such as, "The disclosure concerns," "The disclosure defined by this invention," "The disclosure describes," etc.

The abstract of the disclosure (¶ 0045 on page 25) is objected to because: the via openings shown in the drawings and described in the specification are not "perpendicular to a thickness therethrough" in reference to the inter-metal dielectric (IMD) layer, but rather the via openings run through the IMD (running through the thickness of the IMD layer and perpendicular to the upper surface of the IMD layer), the examiner suggests replacing this phrase with --through the thickness thereof--, if this best represents applicants intention in the original specification; and "said" should be replaced with --the--. Correction is required. See MPEP § 608.01(b).

The disclosure is objected to because of the following informalities: (1) in ¶ 007 on page 4, "interconnect lines. the via opening" must be corrected to --interconnect lines. The via openings--; (2) in ¶ 008 on page 4, "lines, compromises" should be changed to --lines and compromises--; (3) in ¶ 0010 on page 6, "the formation via openings" should be corrected to --the formation of via openings--, to be grammatically correct; (4) in ¶ 0015 on page 9, "be apply" should be corrected to --be to apply--, to be grammatically correct; (5) in ¶ 0018 on page 10, ¶ 0022 on page 11, and ¶ 0029-0030 on page 14, the via openings shown in the drawings and described in the specification are not "perpendicular to a thickness therethrough" in reference to the inter-metal dielectric (IMD) layer, but rather the via openings run through the IMD (running through the thickness of the IMD layer and perpendicular to the upper surface of the IMD layer) – the examiner suggests replacing this phrase with --through the thickness thereof-- in all the instances thereof, if this best represents applicants intention in the original specification; and (6) all numerical references found in the specification must be carefully revised to uniquely correspond to the referenced features as shown in the drawings (e.g., in the description of Figure 2 found in ¶ 0038 on page 17, ARC "22" should be renumbered to the appropriate ARC layer shown in Figure 2 (either --25-- or --26--); in the description of Figure 3 found in ¶ 0040 on pages 17-18, the first dielectric layer "38" must be renumbered as --30-- and the at least one ARC layer "36" must be renumbered to avoid confusion with "photoresist 36", etc.).

Appropriate correction is required.

Claim Objections

Claim 20 is objected to because of the following informalities: in the last step of exposing the photoresist, "the layer of photoresist layer" should be changed to --the layer of photoresist--, to be grammatically correct. Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-10 and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 1 requires that the at least one via opening be "extending substantially perpendicular to a thickness therethrough", but this is not the position and direction shown in Figure 2 and described in ¶ 0030-0039 on pages 14-17. For the purpose of this Office action and in order to advance the prosecution of this application, the examiner is interpreting this phrase in claim 1 in light of the specification and drawings to mean "through the thickness thereof". However, claim 1 must still be amended in response to this rejection. Claims 2-10 are dependent on claim 1.

Claims 5 and 16 recite the phrase "the ARC layer comprises silicon oxynitride", but it is unclear to which ARC layer this phrase refers (the conformal ARC layer, the underlying first ARC layer, or both). For the purposes of this Office action and in order to advance the prosecution of this application the examiner is interpreting this phrase to mean that any of the

ARC layers comprises silicon oxynitride since ¶ 0035 and ¶ 0037 on page 16 both indicate that silicon oxynitride is preferable for an ARC used in deep ultraviolet (DUV) photolithography. However, claims 5 and 16 must still be amended in response to this rejection.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-20 are rejected under 35 U.S.C. 102(b) as being anticipated by Lin, et al. (US Patent 6,042,999).

Lin teaches a robust dual damascene photolithographic process with reduced light reflectance. The process starts by providing a semiconductor substrate having substructure devices formed in or on the substrate, including metal layers (column 4, lines 35-54). A lower layer dielectric (LLD) 110 (pointed out as an intermetal dielectric, IMD, when coated on metal), a thin conformal etch-stop layer 120 (of silicon oxynitride (SiON, SiO_xN_y), silicon nitride (Si_3N_4, SiN, instant claims 6 and 13-14, with a thickness between about 500 to 1,500 Angstroms (Å) – inherently supports coating an ARC layer of the same material to the same thickness, instant claims 8 and 17; also inherently supports coating a second dielectric layer of the same material (SiON, Si_3N_4, SiN) on the first lower dielectric (LLD, IMD), instant claim 20), and/or titanium nitride (TiN), instant claim 3), and an upper layer dielectric (ULD) 130 are formed on the

substrate (dielectric materials include silicon oxide, nitride (Si_3N_4, SiN), or oxynitride (SiON, SiO_xN_y) – inherently reads on depositing a 1st ARC layer since this dielectric material (SiON) has ARC properties pointed out at column 5, line 55; instant claims 2, 5, and 12), followed by forming and patterning a photoresist 145 having an opening 145', as shown in Figure 2a and described at column 4, line 55 to column 5, line 24. Even though described and shown in terms of a single via opening and overlapping trench, column 1, lines 22-31 clearly state the intention of forming plural grooves (trenches) and conductive hole openings (via openings) to form plural multi-level interconnects by repeating the dual damascene process as many times as is required (encompassing formation of plural substantially adjacent via openings, instant claims 10 and 18-19). A via opening 145 is etched through both dielectric layers and the intervening etch-stop layer down to the substrate (metal) using the photoresist as an etching mask, then the photoresist is removed by oxygen ashing as shown in Figure 2b (column 5, lines 24-34). Column 5, lines 35-61 describe forming an anti-reflectance coating (ARC or bottom ARC, BARC which can be either opaque or translucent, and yet not reflect electromagnetic radiation – hints at the usefulness of a second underlying ARC) 150 (of silicon oxynitride (SiON, instant claims 4-5, 7 and 15-16), titanium nitride (TiN, instant claims 7 and 15), or organic material) over the dielectric (IMD, etc.) upper surface and in the via 145, covering the via sidewalls, then forming and patterning another photoresist layer 160 with an opening 165' (trench) over the via opening as shown in Figure 2c (encompasses a "conformally formed" ARC as defined in instant ¶ 0034 on page 15 of the instant specification, instant claims 1, 9, 11).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lin in view of Yu, et al. (US Patent 6,027,861), and further in view of Filipiak, et al. (US Patent 5,918,147).

While teaching at least some portion of all the limitations found in claims 1-20 (even though some of these limitations were interpreted as inherent in the cited reference) as pointed out above, Lin does not directly teach limiting the ARC coating thickness to about 100-1,000 Å and does not specify using plural overlapping ARC layers (though the usefulness of such a combination is hinted by stating that the ARC can be translucent).

Yu shows suitability of a TiN barrier layer (18, 46) as a thin conformal ARC layer (about 200-1,500 Å thick, shown as 18 in Figures 4-6 and as 46 in Figures 8-12) in reducing undesirable back scattering of light during patterning of an overlying photoresist for subsequent etching therethrough to form via openings for metal interconnects in semiconductor fabrication (column 4, lines 33-62 and column 5, lines 27-41).

Filipiak discloses tailoring plural ARC (e.g., silicon nitride, silicon-rich silicon nitride, silicon oxynitride, titanium nitride, etc.) layer combinations to their intended placement in a semiconductor device to avoid reflective notching when patterning an overlying photoresist layer (column 1, lines 11-20). Plural layer antireflective coatings (ARC) disclosed as suitable for

semiconductor device manufacture include ARC 38 in Figure 5 which is composed of portions 380, 382, and 384 (column 3, lines 20-27) and conformal ARC 86 in Figure 10 which is composed of portions 861, 862, and 863 (column 4, lines 36-51). As shown in Figure 6 and described at column 3, lines 48-55, ARC portions 380, 382, and 384 are 50, 100 and 200 Å thick, respectively and are typically only as thick as needed to serve their intended purpose.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the dual damascene photolithographic process for reducing light reflectance taught by Lin as discussed above with additional (conformal) antireflective layer(s) (ARC) 50-1,500 Å thick as shown by Yu and disclosed by Filipiak (encompassing instant claims 8 and 17 for an ARC 100-1,000 Å thick). This is because they all relate to the art of semiconductor device manufacture for the purpose of reducing undesirable reflectance and avoiding reflective notching of a photoresist layer during patterning.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

John Ruggles
Examiner
Art Unit 1756

MARK F. HUFF
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700